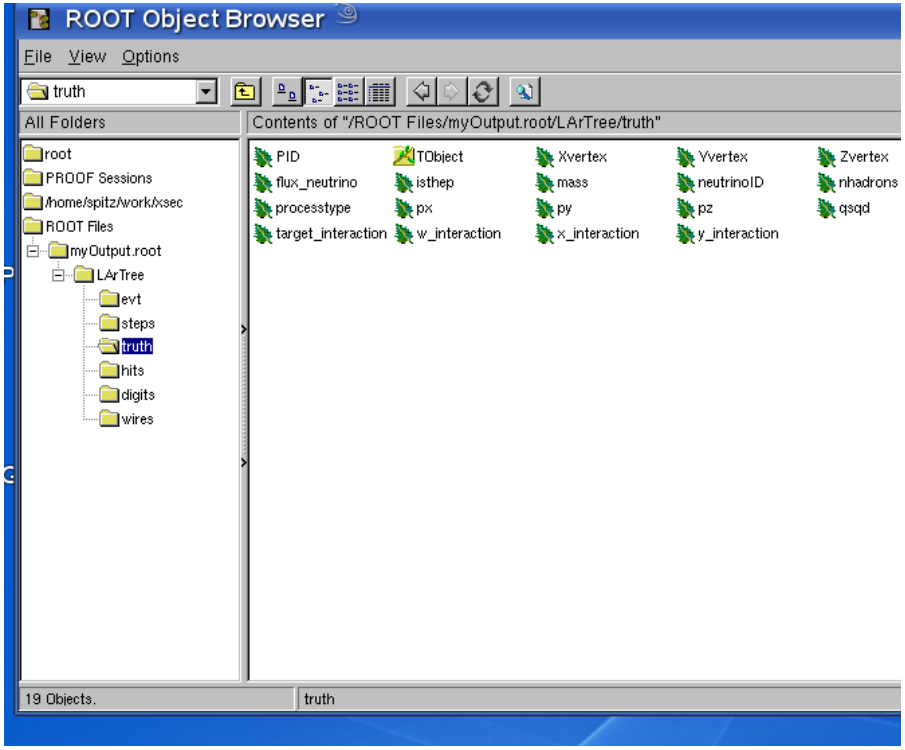
Event generator update

Joshua Spitz

7/29/2008

Updates to ANT_G4

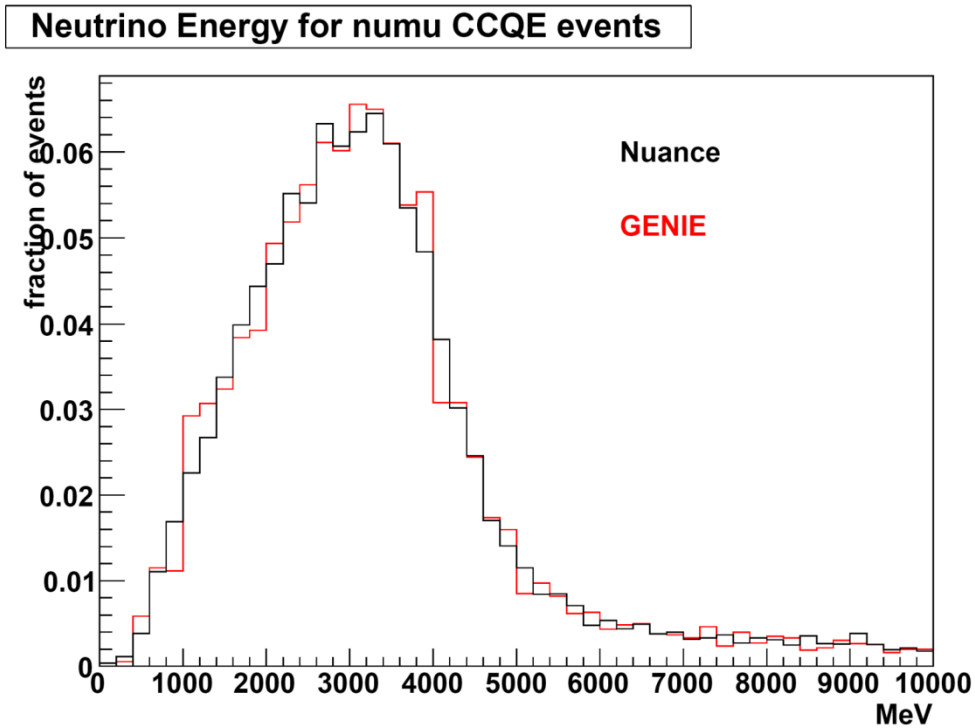
- Genie and nuance generators are fully implemented (NuMI flux 0-50GeV, all neutrinos, detector geometry) in the CVS ANT_G4. A switch in the my.mac file changes between generators.
- ANT_GENIE and ANT_NUANCE
  - Recently upgraded to GENIE v2.4.0
    - Much faster event generation.
    - Flux driver for NuMI is in the works.
  - Nuance and GENIE source are now both available (along with executables and READMEs) in full.
  - Added a dedicated ANT_GENIE reader (.root input) and a dedicated ANT_NUANCE reader (.hbook input). The "Truth" branch is now available for primary particles and interaction info.
  - The GEANT output now includes all information about the neutrino-nucleus interaction (rather than just the post-collision kinematics).

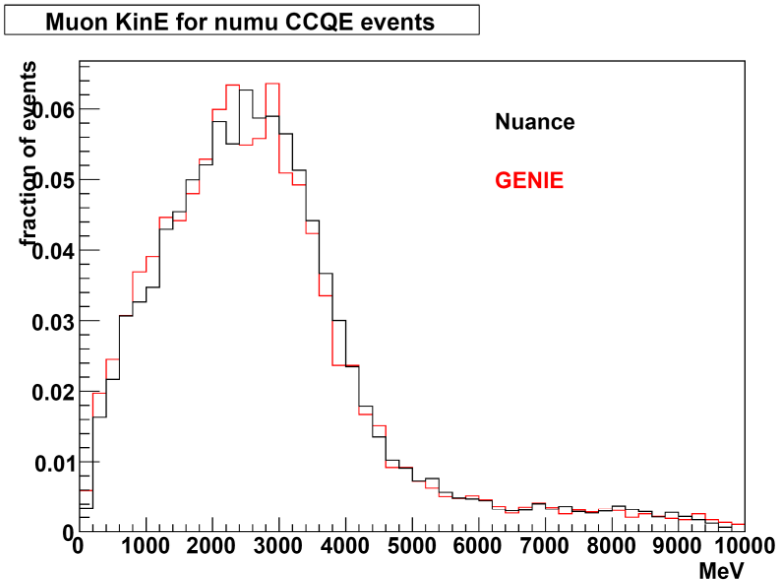


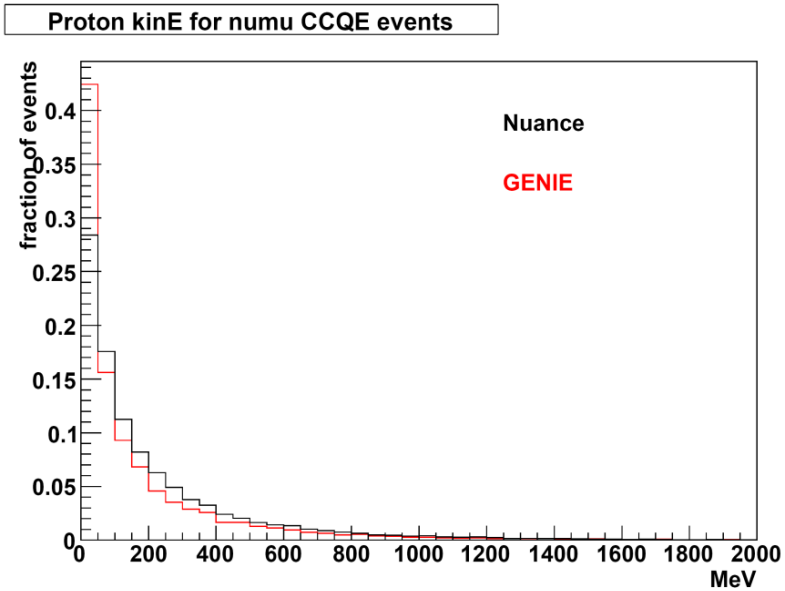
Code changes

- Nuance is designed for neutrino interactions on water.
- We have inherited a nuance version that has been slightly edited for use with argon.
- I have taken this (largely unfinished) version and continued to modify it for argon. This has mainly involved (looking up and then) changing parameters rather than writing code.
- Among the changes,
  - The main parameters in the FG model: Fermi momentum and binding energy. Also, Z and A.
  - The main parameters for final state interactions: nuclear density and differential nuclear density (density changes as nucleons are scattered out of the argon nucleus) parameters have been fixed for argon.
  - The minimum nucleon kinetic energy for tracking has been changed to 10 MeV (MiniBooNE default is 20 MeV).
  - A more precise cross-section calculation is now done by default. The calculation takes about 1 week! However, the calculation need only be done when the detector geometry or flux has changed.
- The convenient channel labeling system of nuance (i.e. 1=CCQE, 2=NCelastic, 3=CCpi+, etc.) has been written into GENIE. Now, we can compare apples-to-apples in terms of reaction channel.

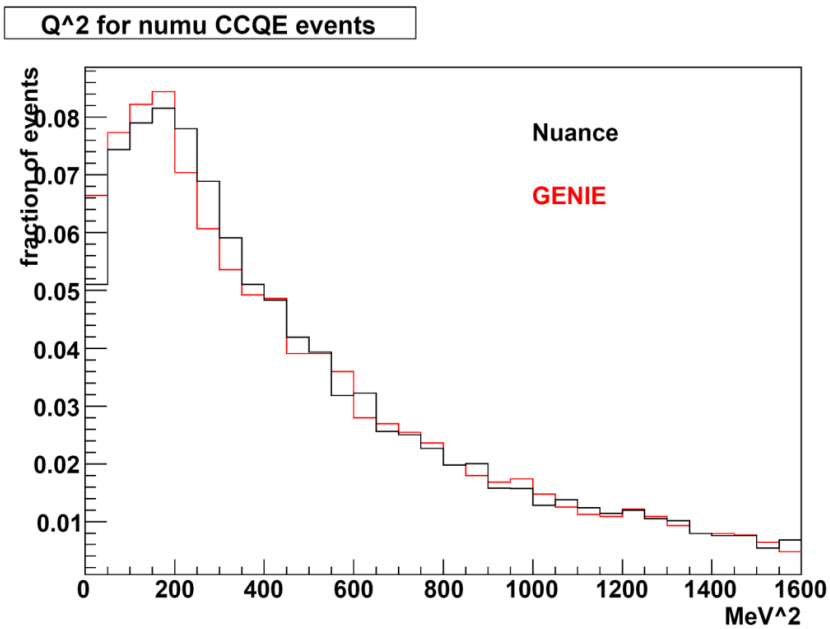
CCQE kinematics

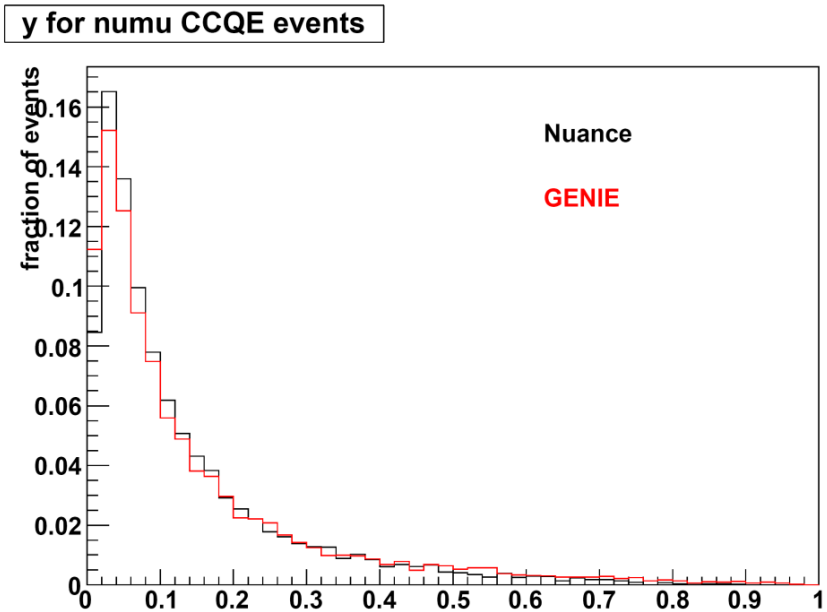


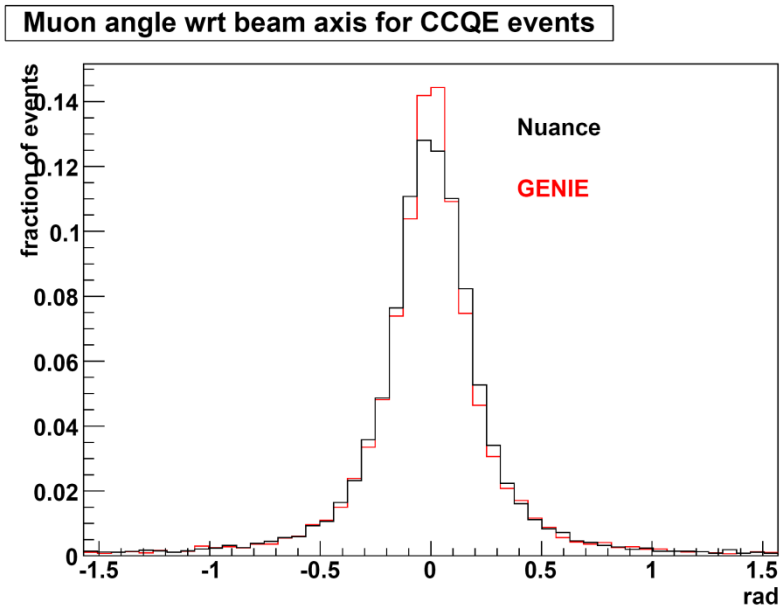




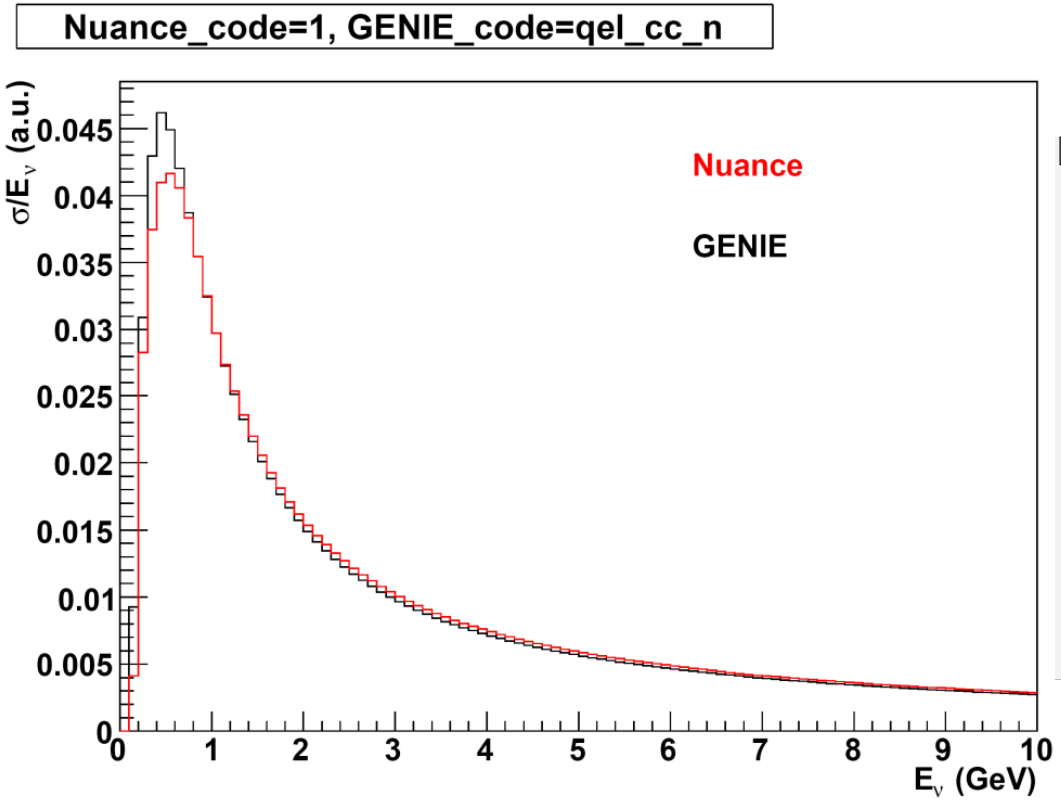
CCQE kinematics continued

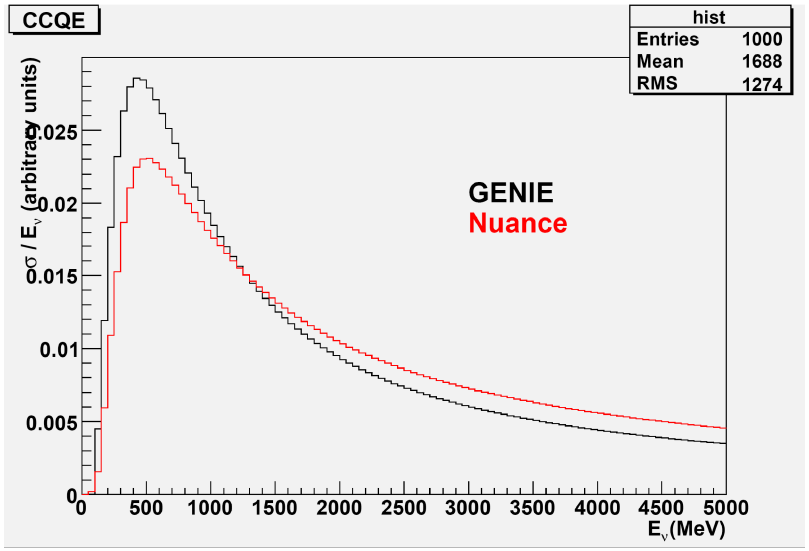






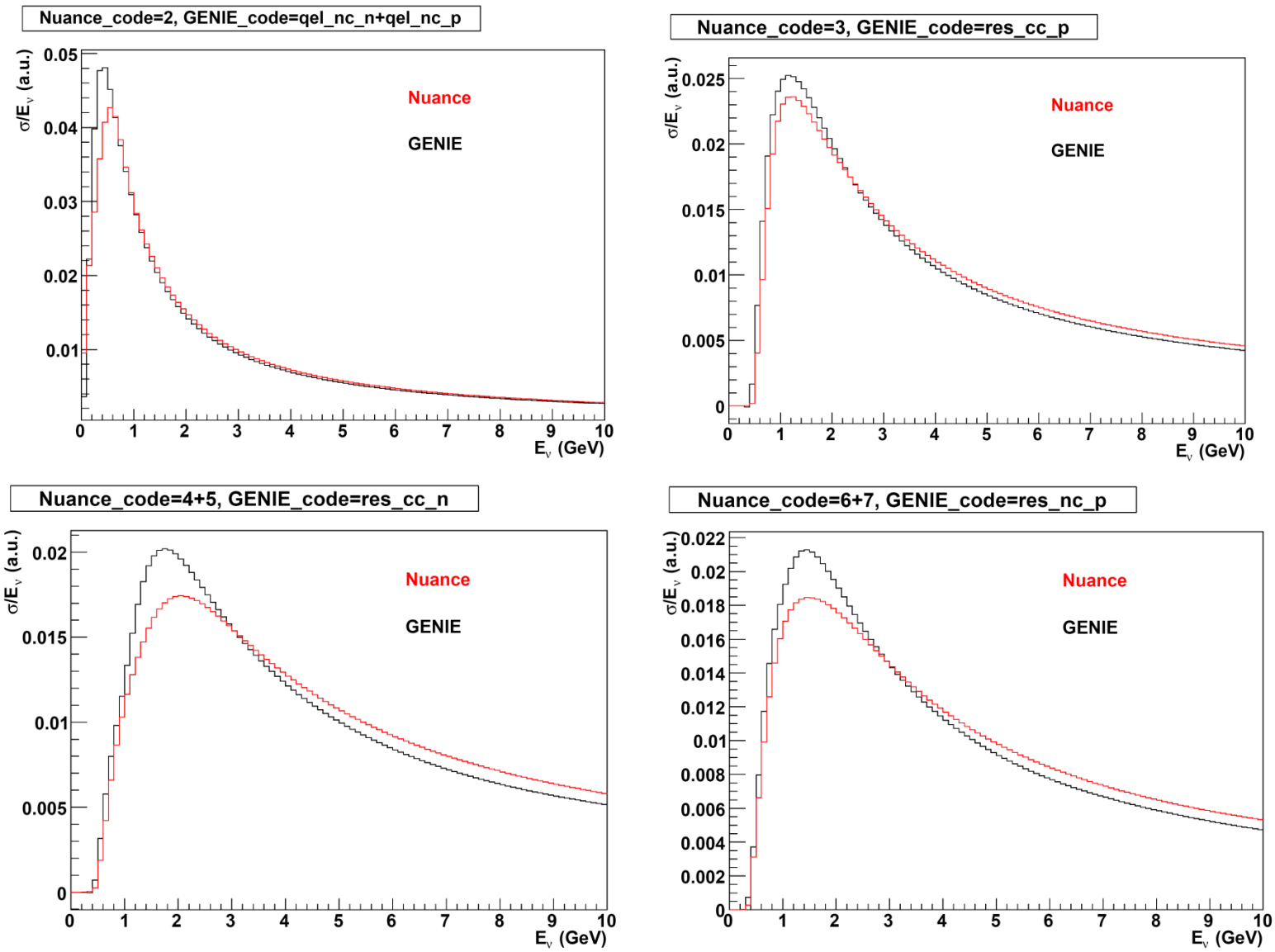
Comparison to last time.

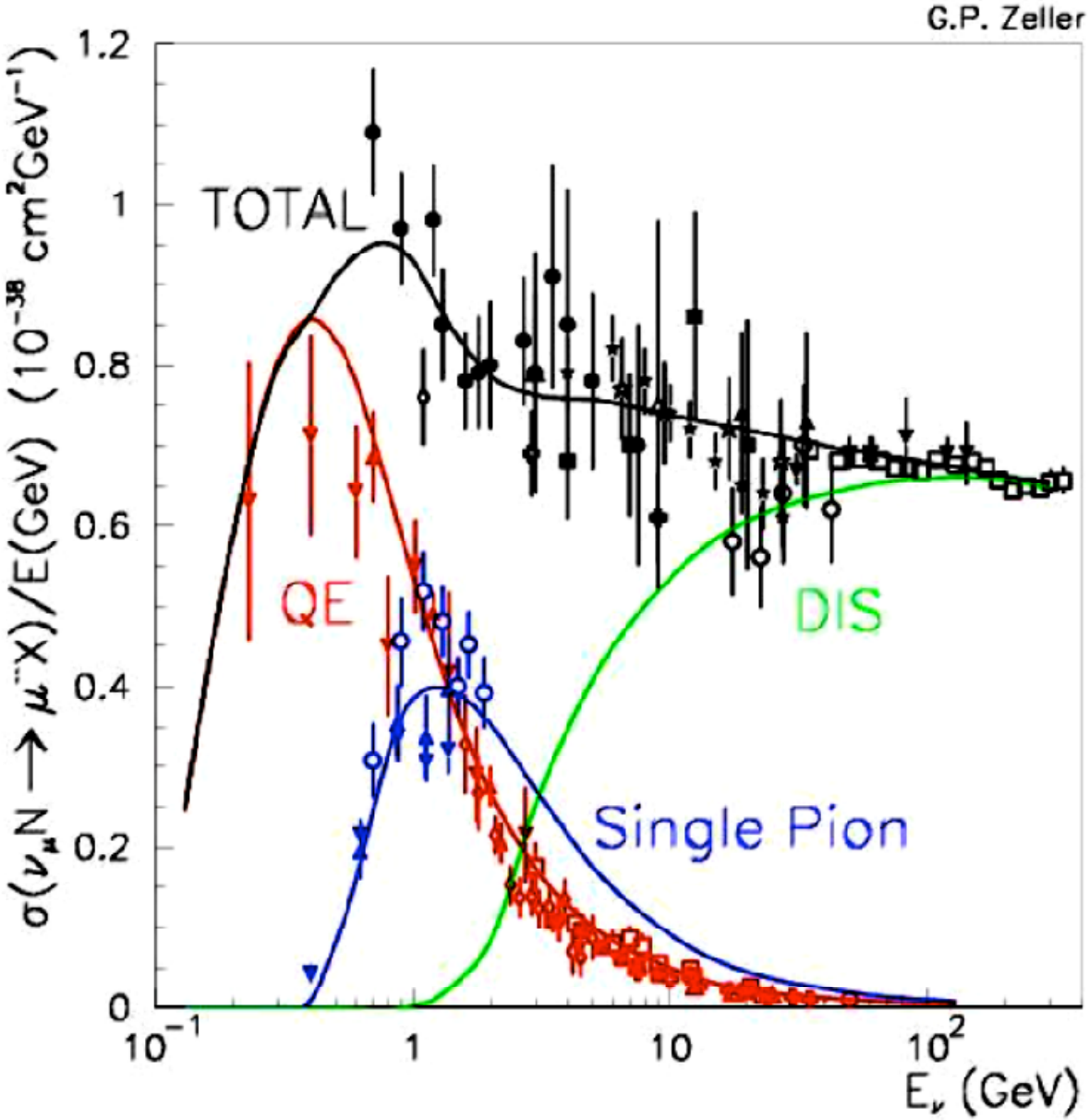




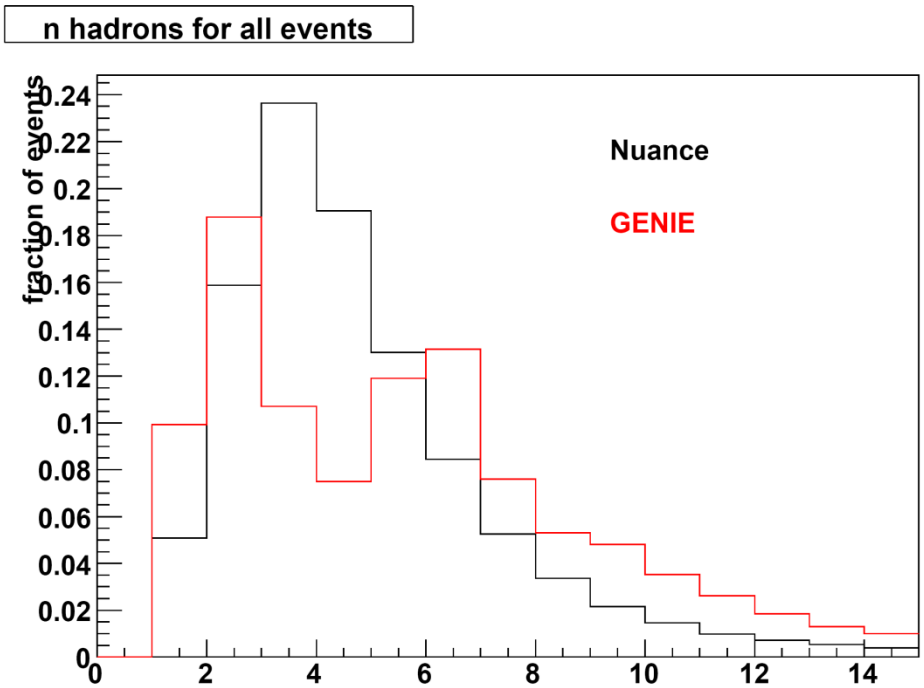
- The nuance code changes have made a noticeable effect.

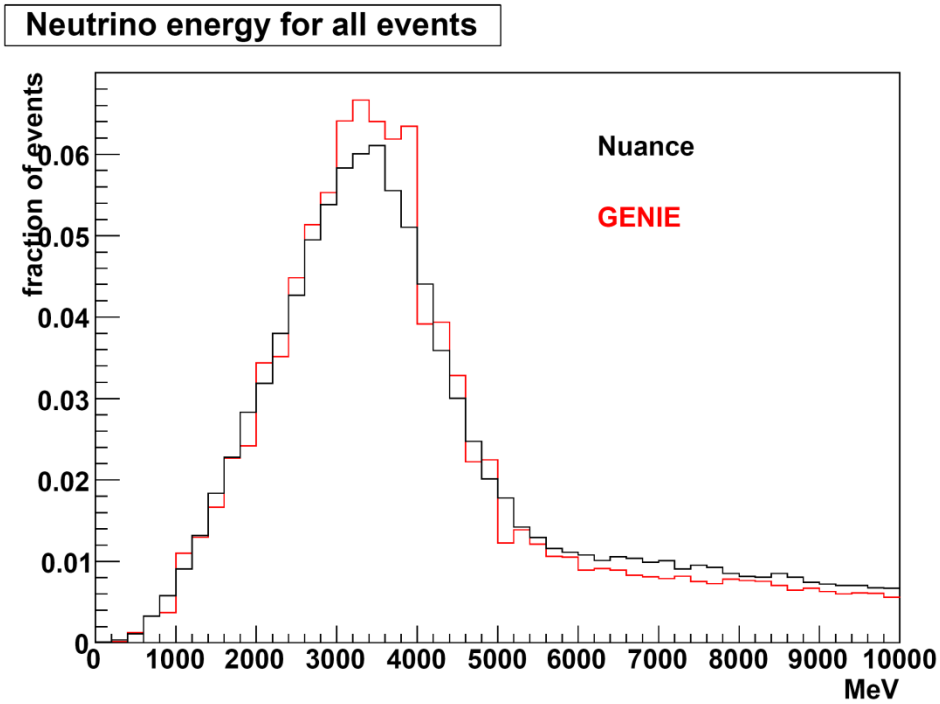
Other cross sections




G.P. Zeller
TOTAL
QE
DIS
Single Pion
$\sigma(\nu_\mu N \rightarrow \mu^- X)/E(GeV)$ $(10^{-38}\ cm^2 GeV^{-1})$
E_ν (GeV)
1.2
1
0.8
0.6
0.4
0.2
0
10^{-1}
1
10
10^2

All events


n hadrons for all events
fraction of events
Nuance
GENIE
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0
2
4
6
8
10
12
14


Neutrino energy for all events
fraction of events
Nuance
GENIE
0
0.01
0.02
0.03
0.04
0.05
0.06
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
MeV

The future

- The event generators are pretty much set until we start discussing cross sections and MC/data tuning.
- An event generator tech note is in the works.
- We can look forward to GENIE software updates and continued argon support from GENIE's development team.